Vascular Access Creation and Care—Perspective From India

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India has one of the fastest growing economies in the world and is home to nearly one sixth of world's population. Chronic diseases such as diabetes mellitus and hypertension are common. Kidney disease is a known complication of these chronic diseases and is on the rise. Improving affordability with advanced care delivery has led to the increasing use of maintenance hemodialysis. Along with this hemodialysis comes the inevitable need for vascular access. Interventional nephrology in India is a fast-evolving discipline and promises to be a critical component of hemodialysis care in the future. This review provides a background on the current state of the CKD burden in India and the various vascular access options in use currently. In addition, we describe the experience of 2 centers in western and southern India in managing vascular access needs in hopes that they will serve as a model of the proliferation of vascular access care throughout India and in other developing countries.

Key Words: Interventional nephrology, Tunneled central vein catheters, Arteriovenous fistula, Bacteremia, Venous stenosis

BACKGROUND

India accounts for one-sixth of the world's population but has one of the lowest doctors-to-population ratio (1:1800) among developing nations.[1] A fast-growing economy coupled with improvement in health parameters leading to changing lifestyles has given rise to chronic diseases such as obesity, diabetes mellitus, and hypertension. A high level of poverty with limited access to preventive care has led to the emergence of renal disease as a major health-care challenge.[2] A population-based study calculated the ESRD incidence to be 152 per million populations. An estimated 55,000 patients are being treated with hemodialysis; this population is growing at a rate of 10% to 15% per year, although this could be an underestimate due to lack of a national ESRD registry.[3] This growth reflects predominantly affluent urban areas where most of the 1500 or so nephrologists and close to 1000 dialysis units are located. Barring a few noted exceptions, a large proportion of nephrology services are offered in for-profit hospitals. The average cost for hemodialysis alone ranges between 20 and 40 US dollars per dialysis session, excluding associated medications. Arteriovenous fistula (AVF) surgery alone may cost anywhere between 200 and 500 US dollars. The lack of governmental support for dialysis expenditure and poor penetration of health insurance lead to heavy dependence on personal and family finances to bear the cost. Unable to cope with this stress on personal finances, the vast majority of patients withdraw from dialysis within the first year after initiation.[2] The improving economy and increasing per capita income among the middle class have resulted in better affordability for long-term maintenance hemodialysis. A public-private partnership driven model of health insurance, providing twice weekly dialysis, is showing promise for patients with ESRD in many states across India.[4]

A recently developed CKD registry of India reports that nearly 48% of patients are in Stage 5 at the time of presentation, leading to dialysis initiation using catheters for vascular access.[5] A significant number of these patients have advanced complications from CKD, such as severe acidosis, pulmonary edema, and fluid overload, which may require non-tunneled femoral catheters for urgent dialysis initiation and stabilization before a tunneled catheter can be placed.[6] Gradually, nephrologists have become more aware of access types, associated problems, surveillance, and various salvage options, such as percutaneous and surgical interventions. Much as the rest of the developing world, the lack of necessary trained personnel to address dialysis access is a major limitation in India. The growing need to provide optimal access care alongside of growth in maintenance hemodialysis has led to the rise of interventional nephrology (IN) in India. The purpose of this review was to summarize this evolution in vascular access care and the role of IN in India.

INTERVENTIONAL NEPHROLOGY IN INDIA

Over the past 30 years, several nephrologists in India have become proficient in constructing AVFs in urban areas such as New Delhi, as well as more semi-urban and rural places where surgical expertise is not readily available. Presently, as rest of the developing world, a variety of specialists are involved in access creation and care, including urologists, general surgeons, plastic surgeons, and vascular surgeons. Nephrologists have also applied their skills to doing vascular ultrasonography (USG) and catheter-based procedures. Notwithstanding a lack of formal training opportunities in IN in India, several nephrologists have begun to perform endovascular interventions for access salvage.

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Although there is limited literature on the true scope of IN practice in India, a variety of procedures including hemodialysis catheter placement, peritoneal dialysis catheter placement and revision, and AVF creation, and, to a limited extent, endovascular interventions are performed to treat complications of dialysis accesses. The other nephrology-related procedures—kidney biopsy and renal artery interventions—are also frequently performed by nephrologists in India.[7]

An online survey conducted by Jha and colleagues revealed many interesting facts about IN in India (unpublished data). Of 123 respondents divided equally between teaching and non-teaching centers, 89% inserted tunneled cuffed catheters, whereas only 28% created AVF. Endovascular procedures were performed by only 7%. A total of 77% of respondents perceived inadequacies in their interventional training and were keen to upgrade their skills through hands-on training workshops and traveling fellowships. A testament to this interest has been the development of regional conferences under the Indian Society of Nephrology and The American Society for Diagnostic and Interventional Nephrology.

CATHETER-RELATED PROCEDURES

Non-tunnel catheters continue to be the primary access for dialysis initiation. Tunnel catheter insertions are now being performed in greater numbers by nephrologists in India. In this section, we describe the experiences in 2 centers of the authors with varying demographics, practice patterns, and clinical setting. Data published by Sampath Kumar originate from a center in south India, and the second center is KEM Hospital, a large tertiary care hospital in Pune, India. One hundred patients using catheter-related procedures were identified and followed up for a cumulative 492 patient months.[8] Demographics of both study populations is summarized in Table 1. The age of the patients in both cohorts was remarkably similar, as was the choice of right internal jugular vein as the insertion vein and the insertion of tunneled catheters exclusively after failure of AVFs. Tunneled catheters as primary vascular access were used mainly in a subset of patients with failure to create AVF, previously failed permanent vascular access, anticipated late recovery from acute kidney injury, those awaiting renal transplant, or those with a short life expectancy and or very poor cardiac function (AVF $< 20\%$).

Tunnel catheter insertions were performed in the cardiac catheterization suite or fluoroscopy-equipped operation theater and have resulted in a high technical success and low complication rate. Ultrasound guidance was used for difficult cannulations and suspected venous occlusion and in small children. The landmark technique was used for most patients without these complicating factors.[9] The complications encountered, divided into early and late complications, are summarized in Table 2. Blood flow obtained with non-tunnel 12G catheters was 249.68 + 47.8 mL/min, whereas tunnel catheters had flows between 250 and 300 mL/min and a mean of 275 mL/min. Kumar and colleagues reported a median period of catheter use of 7 months, whereas KEM Hospital reported an interquartile range median catheter use of 187 days, with 1 patient having used a catheter for 1912 days. A Kaplan-Meier analysis of catheter patency with data censored for renal recovery, access or modalities transition, and patient death with a functioning catheter as an access loss in both centers is shown in Figure 1.

Once a catheter-related procedure is inserted, subsequent problems including flow dysfunction due to fibrin sheath and central venous stenosis are anticipated. Fibrin sheath disruptions by angioplasty balloon and less commonly by snare have been reported. To minimize cost, however, the catheter replacements are more commonly performed without fibrin sheath disruption. In India, urokinase is preferred for intraluminal thrombolysis of catheters over tissue plasminogen activator due to its low cost and availability in smaller vials. Low-dose oral anticoagulation, around 1 mg/d of warfarin in patients with catheter loss due to intraluminal thrombosis has also been successfully used in our practice although accurate data on its effectiveness are unavailable.

CLINICAL SUMMARY

- Prevalence of CKD is raising in India.
- Disparities in dialysis access care are highly ubiquitous.
- Catheters and arteriovenous fistula are primary vascular accesses for hemodialysis.
- Interventional nephrologists in India play a vital role in arteriovenous fistula creation and maintenance.

Catheter-related blood stream infection (CRBSI) is an infamous complication associated with dialysis catheters. The reported incidence of CRBSI varies with definitions used and practice setting. A study reported by Kumar and colleagues reports a CRBSI incidence of 0.4 episodes/1000 patient days, whereas in another tertiary care hospital (KEM Hospital, Pune, India), a decreasing trend in the incidence is noted from 0.89 episodes/1000 patient days analyzed in 2008 to 0.567 in 2015 at the time of writing.

NEPHROLOGIST AS ACCESS SURGEON

In a developing country as India, it is not uncommon for nephrologist to start his practice where renal services were hitherto unavailable. One of the challenges faced by many is to find a surgical colleague well versed in the technicalities of creating a successful AVF especially. By necessity, some nephrologists assume the role of access surgeon by getting trained to create permanent access. In one of the largest series of AVF creations by a nephrologist in India, Balasubramaniam and colleagues presented their experience of creating over 1900 fistulae over 18 years of practice in comparison with 600 created by surgeons.[10] Side to side configuration in the wrist area was the predominant type of access created and resulted in a high success rate of (94% vs 96%). This study provided the much-needed evidence that AVF creation by nephrologists in India is feasible and provides comparable outcomes.